

AI-Powered USB Handbook

USB

AI-Powered USB Handbook Team

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1. AI-Powered USB Handbook

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AI-Powered USB Handbook	USB	USB 3.2 Gen 2x2	Thunderbolt 4 (4)
Type-C			

1.1

- -
- **USB** - USB
- **USB** -
- **Thunderbolt** -
- - USB PD
- -

1.2

-
-
-
-

2. 1 (Introduction)

2.1

USB (Universal Serial Bus)

Type-C

USB

USB 3.2 Gen 2x2

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USB

AI

2.2

- 4 USB4
 - USB

2.3

- 1.
 2. USB 1.0 USB4
 3. Intel Thunderbolt USB
 4. USB PD PPS
 - 5.

3. 2 USB (USB Connector Types)

USB

3.1 USB Type-A

USB

-
-
- **USB 2.0** 4
- **USB 3.0+** 5 9

USB Type-A Illustration

3.2 USB Type-B

- **Standard-B**
- **Micro-B (USB 3.0)** Elements USB 3.0

USB Type-B Illustration

3.3 Mini USB & Micro USB

- **Mini USB** MP3
- **Micro USB** USB 2.0

Mini & Micro USB Illustration

3.4 USB Type-C

-
-
- DP Alt Mode 240W USB PD
- 24 22 CC (Configuration Channel)
- **Type-C** Type-C USB 2.0 4

USB Type-C Illustration

4. 3 USB (USB Transfer Protocols)

USB USB-IF (USB)

4.1

- **USB 1.0 / 1.1:**
- **Low Speed:** 1.5 Mbps ()
- **Full Speed:** 12 Mbps
- **USB 2.0:**
- **High Speed:** 480 Mbps " "

4.2 USB 3.x

		(2013)	(2019)		
USB 3.0	USB 3.1 Gen 1	USB 3.2 Gen 1	USB 3.0 / 5Gbps	5 Gbps	8b/10b
N/A	USB 3.1 Gen 2	USB 3.2 Gen 2	USB 3.1 / 10Gbps	10 Gbps	128b/132b
N/A	N/A	USB 3.2 Gen 2x2	USB 3.2 / 20Gbps	20 Gbps	128b/132b

USB 3.2 Gen 2x2 Type-C Type-C

4.3 USB4

USB4 Intel Thunderbolt 3

- **USB4 Gen 2x2:** 20 Gbps
- **USB4 Gen 3x2:** 40 Gbps ()
-
- **(Tunneling)** (USB 3.2) (DisplayPort) PCIe
- USB 3.2 USB 2.0 Thunderbolt 3

5. 4 Thunderbolt () (Thunderbolt Technology)

Thunderbolt Intel Apple " " " "

5.1 Thunderbolt 3 (3)

- USB Type-C
- 40 Gbps
- PCIe x4 () DisplayPort (5K/8K) USB
- 3 USB 3.x USB

5.2 Thunderbolt 4 (4)

4 40 Gbps

5.2.1 4 vs 3

1. PCIe	4	PCIe	32 Gbps (3 16 Gbps)	(eGPU)	SSD
2.	4	4K	8K (3 4K)		
3.		Intel VT-d DMA	DMA		
4.	4	(Hub)	1 3 3	(Daisy Chain)	

5.3 Thunderbolt vs USB4

- USB4 3
-
- **USB4** " " 20Gbps 40Gbps PCIe
- **Thunderbolt 4** " " 40Gbps PCIe Intel
- **Thunderbolt 4 USB4** " "

6. 5 (Charging & Power Delivery)

USB 2.5W (5V 0.5A) 240W

6.1

- **USB BC 1.2 (Battery Charging)** 7.5W (5V 1.5A)
- QC (Quick Charge) OPPO VOOC SCP/FCP

6.2 USB PD (Power Delivery)

USB PD USB-IF Type-C

6.2.1

- **PD 2.0 / 3.0:** 100W (20V 5A)
- 5V, 9V, 15V, 20V
- **PD 3.1: EPR (Extended Power Range)** 240W
- 28V, 36V, 48V

6.2.2 PPS (Programmable Power Supply)

PPS PD 3.0 20mV - " " PPS

6.3 (E-Marker)

Type-C

- **3A** C-to-C 60W (20V 3A)
- **5A E-Marker** " 5A " 100W (20V 5A)
- **EPR** PD 3.1 240W

7. 6

(FAQ & Common Misconceptions)

7.1 Q: Type-C

A: 1. USB 2.0 E-Marker 3A 65W/100W 2. PD
VOOC 10W 3.

7.2 Q: Type-C

A: Type-C C - **9.9** + USB 2.0 - USB 3.2 (10Gbps) + 4K + 100W - **4** 40Gbps
+ 8K + 240W Logo

7.3 Q: 65W

A: USB PD " " " 9V 2A " 18W PD 5V 1A 5V 2A

7.4 Q:

A: - 5A 4 - USB 3.2